

Coordinated Freeway and Arterial Street Operational Strategies and Procedures

Chapter 3

Coordinated Operation of Traffic On Freeways and Arterials

Draft Document

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3. COORDINATED OPERATION OF TRAFFIC ON FREEWAYS AND ARTERIALS

3.1 Purpose

Previous chapters have provided an overview of coordinated freeway and arterial operations and why it is important. This chapter introduces regional traffic operations as the context within which corridor traffic management plans are developed. It then provides an explanation of the process required to develop coordinated operation of traffic on freeways and arterials within a regional context. Upon reading the chapter, one should have a complete understanding of the issues and processes associated with achieving coordinated operation of freeways and arterials. In addition, sufficient information is provided to develop a Corridor Concept of Operations, the first phase of the Coordinated Freeway and Arterial Framework, which is also presented in this chapter. Subsequent chapters will provide additional detail to take the Regional Concept of Operations through the planning, design, implementation and operations phases.

3.2 Introduction

Management and operations of the surface transportation system has taken on increased emphasis as the surface transportation system matures and becomes more congested. The focus of policy makers is shifting from a construction-oriented emphasis to an operations oriented emphasis. Constructing and maintaining the surface transportation system will still be necessary, but the emphasis shifts to making maximum use of the transportation system infrastructure investment through increased use of techniques that focus on system productivity.

To achieve improved operations requires a broader view of the surface transportation system. This broader view requires more of the surface transportation system agencies to cooperate. This cooperation must take a user view in the broadest sense. Users are fundamentally people and goods, not vehicles. Users are people and goods that are moving from origin to destination through a number of jurisdictions, modes, agencies, and service providers. Too often the planning, design, construction, maintenance and operation overlooks the fundamental reason for existence: service of people and goods from origin to destination.

To achieve a broad perspective of operations requires at least a regional view of transportation system management and operations. It is at the regional level that important policy and planning decisions are made. These policy and planning decisions allocate resources to transportation projects. If scarce resources are not prioritized at the regional level, the ability to achieve maximum system performance is inhibited. It is for this reason that it is important to realize that coordinated freeway and arterial operations can only be successful with a strong regional focus on

improved management and operations of the surface transportation system.

This chapter provides an overview of how corridor traffic management would be developed within the context of a regional traffic management program. The chapter then provides users a framework to develop a coordinated freeway and arterial corridor plan. The development of a corridor plan flows the identification of corridors within the region for which more detailed planning is both warranted and supported by the regional plan. The framework provides a process for developing strategies in a corridor to improve freeway and arterial operations through the development of corridor plan. Using a systematic process that reflects the complex nature of multiple operating agencies and a diverse set of functions is necessary to accomplish the objective because existing processes have a local rather than regional view. Depending on the existing level of collaboration in a region, the process for coordinated corridor operations may begin in several ways. It may begin as part of a broad regional planning process or as part of the desire to address a specific operating problem that spans more than one agency.

Because improved corridor traffic management is part of a broader process, the chapter will begin from a regional perspective. Desirably, the process to begin collaboration will already be underway as the result of planning processes already in place.

3.3 Regional Planning and Coordination

Today's realities require a recognition of the constraints imposed upon further expansion of the highway network, particularly in metropolitan areas, and that the maximization of system efficiency and system preservation need to become higher priorities. Regional planning for operations is a part of this new reality. This new reality must fit within the broader metropolitan planning process, which is undertaken by metropolitan planning (MPO) organizations.

A metropolitan planning organization is a transportation policy-making organization made up of representatives from local government and transportation authorities. The Federal Surface Transportation Assistance Act of 1973 required the formation of an MPO for any urbanized area with a population greater than 50,000. MPOs were created in order to ensure that existing and future expenditures for transportation projects and programs were based on a continuing, cooperative and comprehensive (3-C) planning process. Federal funding for transportation projects and programs are channeled through this planning process.

There are five core functions of an MPO:

- **Establish a setting:** Establish and manage a fair and impartial setting for effective regional decision making in the metropolitan area.

- **Evaluate alternatives:** Evaluate transportation alternatives, scaled to the size and complexity of the region, to the nature of its transportation issues, and to the realistically available options.
- **Maintain a Long-Range Transportation Plan (LRTP):** Develop and update a long-range transportation plan for the metropolitan area covering a planning horizon of at least twenty years that fosters (1) mobility and access for people and goods, (2) efficient system performance and preservation, and (3) quality of life.
- **Develop a Transportation Improvement Program (TIP):** Develop a program based on the long-range transportation plan and designed to serve the area's goals, using spending, regulating, operating, management, and financial tools.
- **Involve the public:** Involve the general public and all the significantly affected sub-groups in the four essential functions listed above.

While LRTPs have been a part of the planning process for many years, operations have not been a significant part of that process. The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) was a landmark piece of legislation. It recognizes that the Interstate Highway System is nearly complete, and that system operations need to become the higher priority.

Further, ISTEA recognizes the changing development patterns, the economic and cultural diversity of metropolitan areas, and the need to provide metropolitan areas with more control over transportation in their own regions. It is this regional focus that forms the basis for regional planning for operations

It is also important to strengthen planning practices and coordination between States and metropolitan areas and between private and public sectors, and improve linkages and connections between different forms of transportation. While metropolitan areas historically have been required to undertake the "3C" process of "continuing, cooperative, and comprehensive" planning, improved regional operations calls for a more system operations oriented planning process to better meet the needs of all constituencies.

Planning for operations is, therefore, a subset of the regional planning process. It is the part of the regional transportation planning process that brings regional collaboration and coordination to bear on operational issues. To achieve this broader vision of the transportation system requires building new processes and procedures. A regional transportation collaboration and coordination development process is shown in Figure 3-1. This process provides a systematic approach to improved regional traffic management, a portion of which is corridor traffic management.

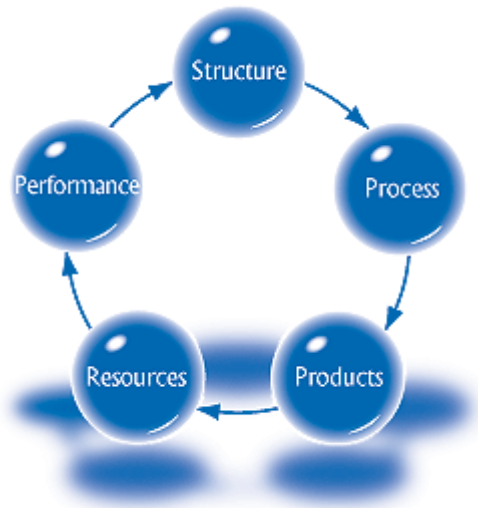


Figure 3-1 Elements in collaboration and coordination framework

The five major elements shown in Figure 3-1 form a collaboration and coordination framework on which to build sustained relationships and create strategies to improve transportation system performance. The intent of the collaboration and coordination framework is to help institutionalize working together as a way of doing business among transportation agencies, public safety officials, and other public and private sector interests within a region. Coordinated freeway and arterial operations is one component of regional operations that can either build upon an established collaboration and coordination framework or the framework can be used as an aid to develop the necessary collaboration and coordination framework.

A collaboration and coordination framework is important in most cases because existing institutional structures create natural barriers that make collaboration and coordination difficult. These barriers include resource constraints, internal stovepipes in large agencies, and the often narrow jurisdictional perspective of governing boards. The framework is intended to guide operators and service providers in overcoming these institutional barriers in order to improve operations by establishing a process, which has been shown to be successful in facilitating collaboration and coordination.

3.3.1 Corridor Planning in a Regional Context

This document is not intended to provide guidance on development of a Regional Transportation Operations plan. It is intended to provide guidance for developing corridor traffic management within a Regional Transportation Operations program. It will focus on including coordinated freeway and arterial operations into the regional program. If the existing level of regional coordination is inadequate to start a coordinated freeway and arterial operations program, other guidance such as the as *Regional*

Transportation Operations Collaboration and Coordination, A Primer for Working Together to Improve Transportation Safety, Reliability, and Security (<http://ops.fhwa.dot.gov/RegionalTransOpsCollaboration>) should be consulted.

By implication, coordination implies having something to coordinate. It is assumed that the reader is familiar with traditional traffic operations strategies including incident management, special event management, work zone management, freeway management, and arterial management. Guidance on these areas can be obtained from FHWA (see: <http://www.ops.fhwa.dot.gov/index.asp>). This document focuses on taking traditional concepts applied at a local level to the next level through coordination and collaboration. The next level for freeways and arterials is coordinated operations. The important point is individual agencies can not individual provide a corridor focus. To achieve better operations, it is necessary to take a broader focus.

3.3.2 Establishing Corridor Management Within a Region

The first step in developing coordinated freeway and arterial operations is understanding that it is a regional function as illustrated in Figure 3-2 from the Maricopa Association of Governments Guidelines for Regional Transportation Operations¹. The figure illustrates that certain functions can only be done with cooperation and collaboration at the regional level, not at the local or individual agency level. Local agencies cannot achieve coordinated operations based on their individual actions. It is also important to understand that the development of coordinated freeway and arterial operations program must occur in a regional context. That is the need for a Corridor Plan must be recognized and supported at the regional planning level before it can be developed and implemented.

¹ MAG Regional Concept of Transportation Operations, Guidelines for Regional Transportation Operations, Maracopa Association of Governments, January 7, 2004, <http://www.mag.maricopa.gov/detail.cms?item=3431>.

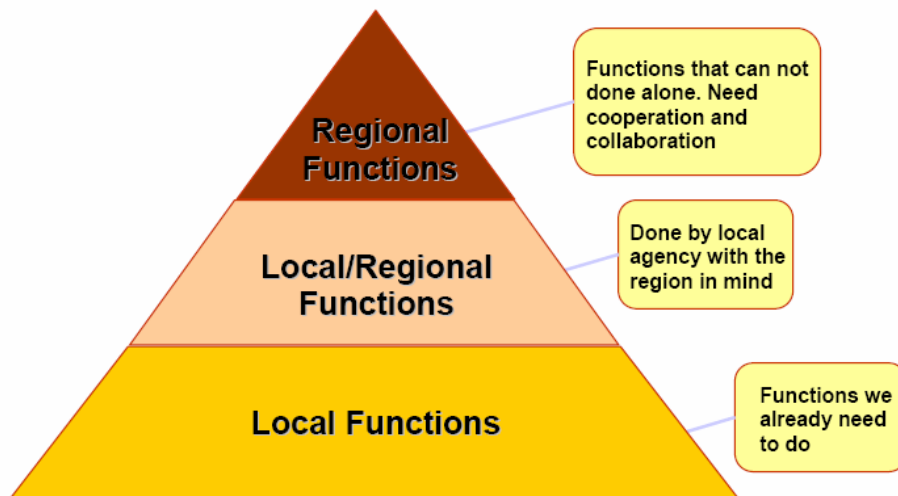


Figure 3-2 Relationship Between Regional and Local Functions

3.3.3 Establishing a Corridor Focused Process

Once corridor level planning is established at the regional level, the next step is the development of a process that focuses on corridor level issues. The objective at the regional level is the identification of corridors that have operational problems that would benefit from coordinated freeway and arterial operations.

Traditionally, operations have had an agency or local focus. Even within departments of transportation, freeways and arterials have been operated based on a local focus. Types of local level focus include:

- Freeway mobility
- Arterial mobility
- Local traveler information

To improve corridor operations requires a broader regional focus. As shown in Figure 3-2, a regional level of focus requires collaboration and coordination. Regional level focus adds:

- Multi-agency coordination of
 - Freeway mobility
 - Arterial mobility
 - Traveler information
- Multi-agency sharing of
 - Data
 - Resources

The reason to provide a regional level of coordination is to improve system level performance for the benefit of travelers. Agencies cannot individually achieve a system level of acceptable traveler service.

Figure 3-3 shows the relationship between local and regional functions developed by the Maricopa Council of Governments for their region. Figure 3-3 is only an example to show how a regional focus was established using existing agencies. Each region would need to tailor their approach to reflect local organizational structures.

It should also be noted that Figure 3-3 is based on the Maricopa Association of Governments Regional Concept of Operations¹ which provides the Vision and Goals for regional operations as well as a high level view of the initiatives and performance improvements that collaboration and coordination may achieve.

Once the process is established, the focus of the regional corridor operations planning process is the identification of the corridors warranting further study and the resources required to develop a Corridor Plan. The development of a corridor plan is part of the corridor level planning process discussed in detail in Section 3.4. At the regional level, the objective is simply the identification of opportunities and the necessary resources to develop and implement a solution.

The formality and the extent of the process will depend upon many variables including the complexity of the issues (e.g., new multi-jurisdictional traffic control center versus coordinating signal timing between jurisdictions with compatible systems). The regional process is largely a scoping and budgeting effort.

The regional process is essential two-stage. Stage 1 is identification of the corridors that warrant attention and funding the development of a Corridor Plan (unless sufficient resources exist in house to develop the Corridor Plan). Stage 2 is funding the projects result from the Corridor Plan. The corridor Plan (see section 3.4.7) is document providing the strategies to be implemented and the necessary resources for design, construction, operations and maintenance.

Regional Concept of Transportation Operations: Oversight and Scoping Framework

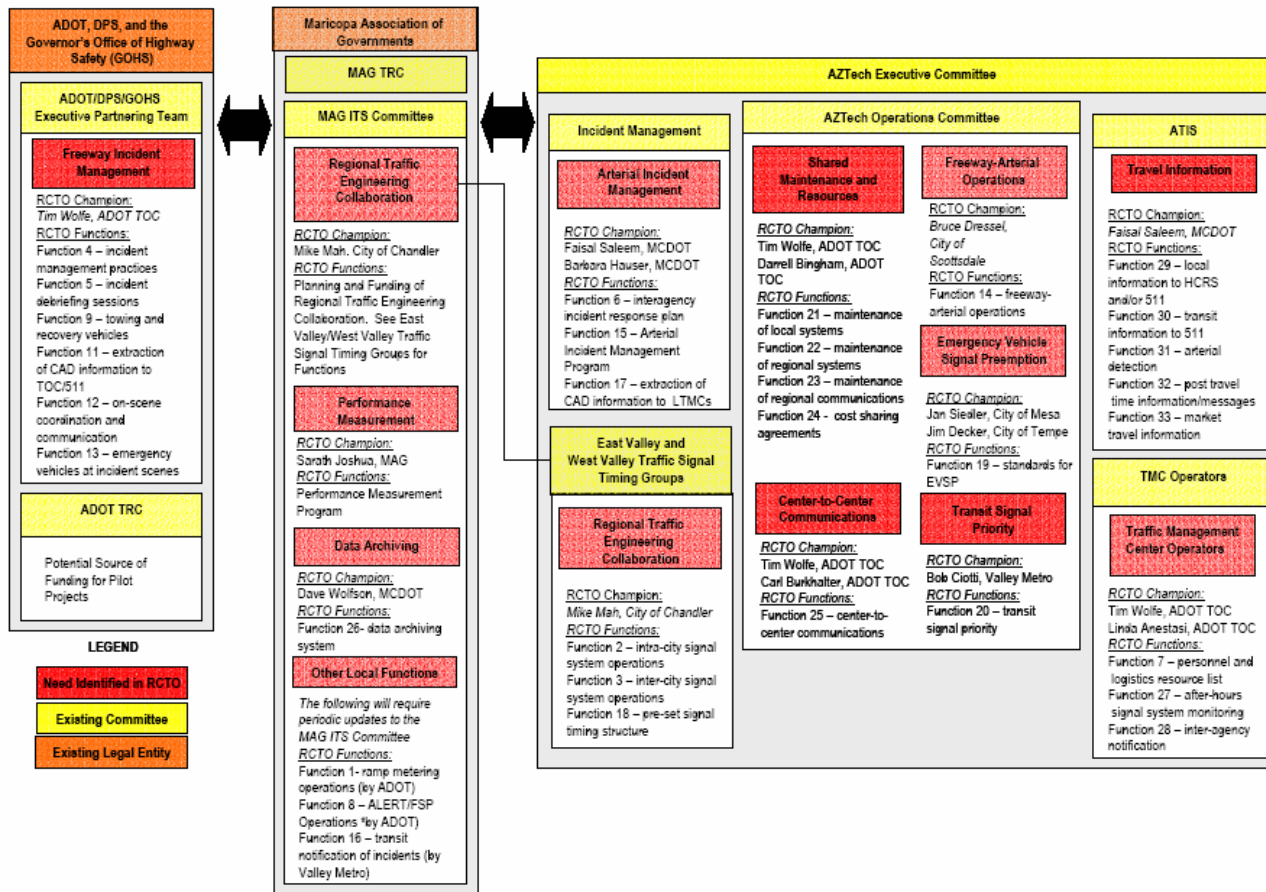


Figure 3-3 Example of Integrating Regional and Local Processes

3.3.4 Regional Corridor Products and Resources

The result of the regional corridor planning process is the identification of the corridors warranting further study and the resources necessary to develop a corridor plan

3.3.5 Regional Performance Measures for Corridor Operations

Performance measures are needed to enable the region to quantify how well the corridor operations initiatives are meeting the Regional Concept of Transportation Operations goals. From a traveler perspective, the most basic measure of performance is travel time (or average speed). This is an important regional performance measure because it reflects the total characteristics of the trip.

Other systemwide measures include:

- Travel time reliability
- Availability of traveler information
- Impact of incidents

3.3.6 Putting It All Together

To achieve a shared regional vision and goals for improved transportation operations, a number of institutional matters need to be addressed and the resources provided. These issues have been briefly discussed in the context of a regional framework for collaboration and coordination. Because of the varied existing structures and processes, it is not possible to provide a simple roadmap to success.

Achieving coordinated freeway and arterial operations will require the development of appropriate new policies, procedures and practices needed to achieve the new vision.

Policies are essentially the written goals and intention of the various agencies. To achieve corridor level coordination and collaboration will likely require existing policies to be expanded.

Procedures are written, well-defined steps, to implement an aspect of regional transportation operations. Practices are those activities that are routinely done, but for which no formal document exists that directly describes the activities.

In order to improve corridor traffic operations requires the development of new procedures and practices. In the area of corridor traffic operations,

issues to be addressed with new procedures and practices include:

- Optimization and coordination of signals between agencies
- Optimization and coordination of traffic signals and adjacent ramp meters
- Altering freeway ramp meters during freeway and arterial incidents
- Altering arterial signal timing during freeway and arterial incidents
- Sharing data on incidents and traveler advisories
- Sharing DMS signs during various events
- Sharing control when agency is not staffing operations

Keeping the momentum requires continuing attention. This can be done through establishment of written procedures, which can be facilitated by establishing memorandums of understanding. These written agreements for the foundation of the program by committing the agencies to sustaining the Regional Concept of Operations

3.4 CORRIDOR LEVEL PLANNING AND COORDINATION

This section will expand the elements shown in Figure 3-1 into a Coordinated Freeway and Arterial Framework. The framework will include the five elements (structure, process, products, resources and performance) into a more detailed framework specifically tailored to the coordinated freeway and arterial operations.

The Coordinated Freeway and Arterial Framework for corridor traffic management is shown in Figure 3-4. It is a scalable process that could be used in a large or small corridor. The process shown in Figure 3-4 provides a systematic way to work through all the elements of coordination and collaboration (structure, process, products, resources and performance) associated with improved corridor traffic operations. Because corridor traffic management is typically fragmented due to the institutional make up of the agencies involved in corridor traffic operations, the framework provides a process to overcome the institutional seams, which inhibit coordination and collaboration.

The 11-step framework for corridor operations collaboration and coordination in Figure 3-4 are summarized in this chapter. The first four steps, which are discussed in detail in this chapter, result in a Corridor Concept of Operations, one of two principal products (highlighted in Figure 3-4) of the 11-step process. The next chapter will provide more detail on the development of the Corridor Plan, the second major product of the 11-step framework. Later chapters will discuss specific corridor operations applications. The 11-steps provide the means to achieve

coordination and collaboration both between agencies and also within agencies.

It should be emphasized, however, that the process is cyclic. It essentially never ends and often requires recycling (iterating) between items in order to resolve competing issues. For example, a strategy may be selected for evaluation and selection. Upon evaluation, the strategy may require more resources than are available, requiring a reconsideration of alternative strategies more consistent with available resources.

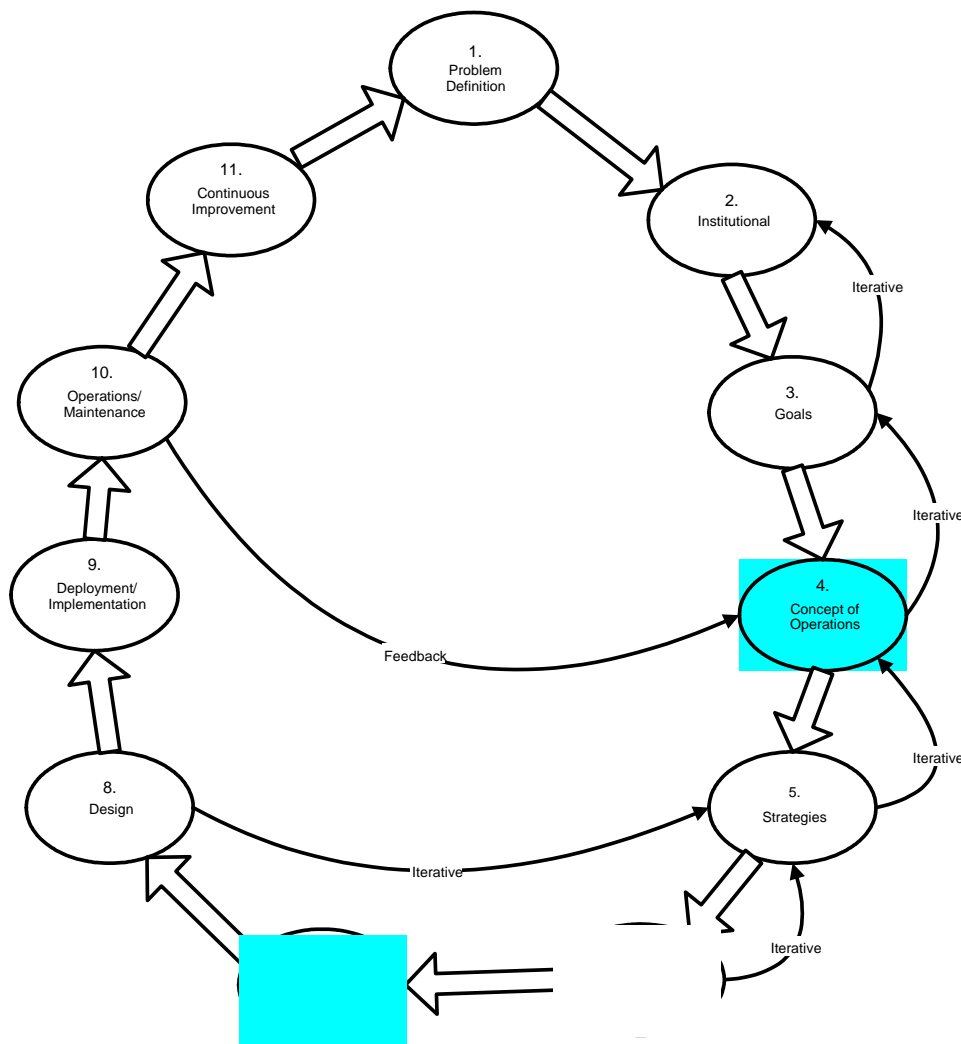
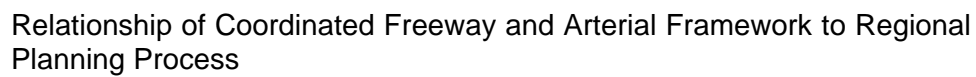


Figure 3-4. The Coordinated Freeway and Arterial Operations Process

3.4.1 Problem Definition

There needs to be a reason for undertaking coordinated corridor operations and management, a “problem.” A problem may be identified either through a formal performance monitoring process which may be part of a regional planning process or as the result of an obvious operational problem such as traffic backing up onto a freeway as the result of an arterial signal. The definition of the problem in the broadest sense will actually begin at the regional planning and coordination stage discussed in section 3.3 and shown in Figure 3-5 as a higher-level process. The important point shown in Figure 3-5 is that there is an iterative process between the Regional Planning Process and the Corridor Planning Process. Problems can originate at either level. At the regional level, it is a planning and programming function. At the corridor level, it is a more detailed level process.



The cause of a problem may be easy to identify, such as the lack of traffic signal coordination between to adjacent jurisdictions. However, it can also require more extensive analysis when congestion is more widespread. Under such conditions, it may require more extensive data collection and analysis to determine the true bottlenecks in a system experiencing extensive congestion. Discussion of alternatives/strategies, and evaluation/selection will be described in more detail in Chapter 4.

The types of problems that are amenable to coordinated corridor operations include:

- Incidents
- Work zones
- Special Events
- Day-to-day (recurrent) congestion

Incidents on freeways are the most readily addressed form of freeway congestion. Traditional actions like motorist service patrols which focus on quickly removing incidents directly mitigate the effects of incidents. However, incidents may have significant secondary effects in major travel corridors, resulting in diversion to arterial streets. More significant corridor problems are also likely to result from major construction projects. Special events can also generate large traffic volumes, often at what would otherwise be off-peak times, creating congestion because of increased traffic volumes and/or unusual traffic patterns. The resulting corridor congestion can often cause significant delays to traffic that is not involved in the special event and was not aware of the benefit of avoiding the special event venue. Specific issues related to these will be discussed in Chapters 5-8.

Although problem definition is the point of beginning, it is also the outcome of a continuous corridor improvement process as illustrated That is, the coordinated operations process should identify on an on-going basis either opportunity to improve current plans or need for new approaches for potential evaluation. If the continuous improvement process can be handled on a routine basis, it is just feedback into day-to-day operations. If the problem requires more extensive resources, the information would be past up to the regional level for consideration.

Initially, processes may not be in place to easily identify problems based on performance measurement systems (e.g., freeway and arterial performance measurement systems using detection and data archiving). Problems will be identified by more ad hoc systems. Travelers may record their concerns with public agencies, but the public agencies discard the problems as being outside their jurisdiction. It is likely that agency professionals are aware of problems that they believe are outside their responsibility. Problems initially identifies at the local level should also be provided to the regional level for consideration.

While it is easy to identify symptoms of problems, it may be more difficult to identify root causes. Furthermore, what one stakeholder sees as a problem may not be viewed as a problem by other stakeholders. Some local jurisdictions may not want to accommodate freeway diversion traffic.

Lack of an initial consensus does not mean a solution cannot be found. Often, two problems that seem unsolvable may be packaged into a consensus solution where each side gives a little to get a little or hopefully get a lot. The important point is to create an environment where mutual problem identification is possible as the first step towards resolution. The next critical step is the framework to work through the solutions. The framework must provide a level playing field where all stakeholders feel safe explore issues and find win-win solutions. Without an opportunity for win-win solutions, coordination and collaboration will stop when the disenfranchised party leaves. Coordination cannot take place when one or more parties are placed in a losing situation for their agency. The next section discusses the institutional framework and considerations necessary to solve corridor problems through coordination and cooperation.

3.4.2 Institutional Framework and Considerations

An institutional framework is needed to provide a structure upon which the 11-step process can address problems and develop solutions that stakeholders can support and implement. Typically, agencies respond to problems in their jurisdiction or operating environment. Because corridor solutions require participation of multiple stakeholders, potential conflicts are inevitable. The establishment of a level playing field with the broadest constituency reduces the potential for failure caused by a non-participant sniping at the efforts, which do not represent their interests. The purpose of establishing a corridor traffic management framework is to bridge the agency structures in order to address an identified problem in a manner that all affected stakeholders can support.

Some of the lessons learned from inter-jurisdictional coordination include:

- Face-to-face interaction is important
- Let each partner focus on its strength
- Address high visibility problems
- Identify common interest
- Proceed incrementally
- Don't over-promise
- Have a high-level champion

It is necessary to establish either a formal or informal institutional framework for the specific coordinated corridor being addressed in the corridor planning process. At the regional level, the stakeholders may be

more numerous and have higher-level responsibilities. At the corridor level, those responsible for day to day operations or who are corridor users need to be at the corridor planning meetings.

This new corridor traffic management structure can be very ad hoc or very formal depending on the current state of coordination in the region and the complexity of the undertaking. There is no perfect framework because of the unique nature of each urban area. The important point is to realize that an overarching structure is necessary to bridge the seams between the various agencies and even functions within agencies. The corridor-planning group will hopefully be a subgroup or subcommittee of the larger regional planning group.

The mechanisms range from ad hoc/informal relationships to formal structures with legal standing. They include personal relationships among leaders and staff members of key operating agencies and neighboring jurisdictions who recognize common problems and opportunities and agree to work together to improve corridor performance. These structures may evolve from or evolve into a broad-based regional partnership among public and private sector interests across multiple jurisdictions. Several examples illustrate the variety of structural approaches to collaboration and coordination:

Ad hoc arrangements based on long-term relationships or immediate needs emerge during major reconstruction projects or roadway incidents where agencies agree to collaborate in the time during and after the event, but no formal, long-term agreements govern the collaboration.

Formal, multiagency partnership agreements are often used for single or recurring special events (such as for political conventions or Independence Day celebrations), and full-time staff are dedicated to planning for operations prior to the event. Formal, multiparty agreements may remain in place after the event.

To be effective, the collaboration and coordination effort must be linked to the regional transportation planning process. Often, what passes for collaboration is directed primarily or solely toward installing a project, solving a problem, or preparing for a special event. For corridor collaboration and coordination to work, it must be part of an ongoing, intentional, focused effort to improve system performance by identifying needs and opportunities and collaborating on strategies and solutions that lead to strategic investments.

The existing transportation system institutional organizational structure in most areas is based on jurisdictions, agencies, and functions within organizations. This specialization has value in delivering services in a cost-effective manner due to its specialization. However, this specialization can have adverse effects on travelers who are less

concerned about organizations and more concerned about making their trip from origin to destination. Bridging these seams in a traveler's trip is the primary focus of coordinated operations of freeways and arterials.

It is worth mentioning there are many stakeholders and perspectives to consider. In order to achieve the desired outcome, all relevant stakeholders need to be identified and engaged in the process from the beginning. Without adequate buy-in, success is unlikely. It is also difficult to get buy-in when stakeholders are brought into the process at the late stages.

In addition to having all appropriate stakeholders, it is necessary to understand their perspectives and issues. If traffic engineers seek only to minimize traffic disruptions caused by emergency workers, success is unlikely. However, if traffic engineers realize emergency workers have priorities (like protecting their safety), problems can often be recast into win-win solutions. Better traffic management becomes improved emergency worker safety and less exposure to potentially dangerous secondary traffic accidents caused by poor traffic management.

Stakeholders and perspectives include:

Users are the primary customers of the transportation system. Users include those that use motorized transportation (e.g., motorcycles, automobiles, trucks, light and heavy rail, buses) as well as those that use non-motorized transportation, such as walking and bicycling. These customers are interested in safe, reliable, and predictable trips from their origin to their destination. They are generally not interested in the details of how the system operates, except when they encounter a system failure or disruption that influences the convenience or reliability of their trip. Additionally, users want real time and accurate travel condition information to guide them on their trip.

Decision Makers (i.e., elected officials, agency heads, etc.) develop legislation and policies addressing the funding, implementation, and management of the surface transportation network. They also decide where public resources are allocated. They need to understand society's needs and allocate available resources to best satisfy those needs. They also want to know the effects of their allocations.

Responders, such as police, fire, and other emergency services, represent a "special user" category. They utilize the transportation network as part of their critical missions, and often have decision-making and operational responsibilities for the network, particularly during traffic incidents, special events, and emergencies.

Practitioners (i.e., agency managers, planners, designers, implementers, operators, maintenance staff) are responsible for implementing the transportation projects and for day-to-day management and operation. In essence, they are the “providers” – providing the many functions and services requiring collaboration and coordination. They use the resources provided by the decision makers to provide travelers with the transportation services, travel modes and options, and information that meets the users’ needs. These practitioners represent many different types of transportation agencies, including federal, state, county, city, transit, and regional organizations.

Activity Centers and Service Providers, such as private traveler information providers, airports and ports, private towing entities, stadiums, festivals, etc., can significantly impact the operation of the transportation facilities provided by transportation agencies.

3.4.2.1 Establishing a Structure

The action steps necessary to establish a corridor traffic management program include identification of stakeholders and identification of champions. The process for sustaining the program may be ad hoc or formal. Ad hoc arrangements tend to work best when long-term relationships between entities already exist or when the effort emerges from a specific project of limited duration. Formal agreements are used when either the complexity of the endeavor or the long-term nature of the undertaking require that the effort be implemented with formal agreements. Formal agreements can address many local issues including responsibilities and resources.

Examples of legal entities include Houston’s TranStar (<http://www.houstontranstar.org/>) and metropolitan New York’s TRANSCOM (<http://www.xcm.org/>). These organizations provide a mechanism to *facilitate* collaboration and coordination. They do **not** replace existing organizations. While this may seem like an unnecessary administrative layer, that is not the case. Each existing organization has a specific and unique mission, as well as a legal basis and funding. The role of the additional entity is to provide a legitimate basis for collaboration and a mechanism to fund that collaboration.

3.4.2.2 Identify Corridor Stakeholders

The success of a corridor initiative depends on participation by an appropriate set of stakeholders. Involving appropriate organizations at an early stage facilitates buy in by the organization because they are a part of the early decision-making process.

Areas will vary dramatically in the degree to which the corridor stakeholders are interested in improved operations. In areas that have already implemented substantial traffic management systems, the stakeholders may have already been working together. As a result, these areas usually have existing operations management committees that will be a natural forum to discuss corridor traffic management.

Other areas will require more significant education and outreach efforts to assemble and motivate potential stakeholders. Educating the right people is important – frequently the education and outreach efforts will target the management levels in an organization where decisions can be made to commit valuable personnel resources to support the corridor traffic management development effort. Without management support, it will be difficult or impossible for those with a working knowledge of operations in the area to participate in corridor traffic management.

It is often best to start with a core stakeholder group and then add participants to the core group over time. Including too many stakeholders at the start can hinder the development process and discourage people with limited vested interest in corridor traffic management.

If it is decided to initially limit the number of participants to a core group, set a timeframe to add others. Table 3-1 provides a list of potential stakeholders to consider.

Table 3-1: Candidate Stakeholders

Transportation Agencies	<ul style="list-style-type: none"> • State Departments of Transportation (DOT) • Local Agencies (City & County) <ul style="list-style-type: none"> o Department of Transportation o Department of Public Works • Federal Highway Administration (FHWA) • Toll/Turnpike Authorities • Bridge/Tunnel Authorities •
Transit Agencies/Other Transit Providers	<ul style="list-style-type: none"> • Local Transit (City/County/Regional) • Federal Transit Administration • Paratransit Providers (e.g., Private Providers, Health/Human Services Agencies)
Public Safety Agencies	<ul style="list-style-type: none"> • Law Enforcement <ul style="list-style-type: none"> o State Police and/or Highway Patrol o County Sheriff Department o City/Local Police Departments • Fire Departments <ul style="list-style-type: none"> o County/City/Local • Emergency Medical Services • Hazardous Materials (HazMat) Teams • 911 Services
Other Agency Departments	<ul style="list-style-type: none"> • Information Technology (IT) • Planning • Telecommunications • Legal/Contracts
Activity Centers	<ul style="list-style-type: none"> • Event Centers (e.g. sports, concerts, festivals, ski resorts, casinos, etc.) • National Park & US Forest Services • Major Employers • Airport Operators
Travelers	<ul style="list-style-type: none"> • Commuters, residents, bicyclists/pedestrians • Transit Riders, others
Private Sector	<ul style="list-style-type: none"> • Traffic Reporting Services • Local TV & Radio Stations • Travel Demand Management Industry • Telecommunications Industry • Private Towing/Recovery Business

It is also important to focus stakeholder participation appropriately. For example, both planners and system operators may participate in the

process, but with substantially different focus. System operators may be more interested in the operational concepts, functional requirements, and interface definitions, while the planners may have more substantial input while identifying transportation needs and services and project sequencing. Other individuals with specialized knowledge will be needed to assist in development of the list of agreements. As the “stakeholder roster” is developed, consider the various areas of expertise that are required and use your stakeholder resources selectively. Different stakeholders should be engaged in different parts of the process, consistent with their expertise and interests.

Encouraging broad participation from many agencies in the area will occasionally bring people into the process who aren’t really stakeholders in the transportation system. The objective is to be inclusive without wasting the time of those who do not have a vested interest. Recognize and respect that everyone’s time is limited. Draw participants into the process without bogging them down. Some useful techniques to encourage people with demanding schedules to participate are to make sure everyone gets plenty of time to review documents, and schedule short meetings with teleconferencing options. This will help retain participants that may otherwise give up on the effort due to other commitments.

3.4.2.3 Corridor Champions

A champion is someone who believes in the program and is willing to put in the effort necessary to make it happen. Although a small project may not require high-level champions, the presence of a champion who commands significant resources (people and money), is most desirable.

Regardless of who is the champion, when practical, start small. Small projects have a higher potential for success because of their more limited resource needs. Experience suggests success breeds new undertakings, so a small successful project is better than a large unsuccessful project. However, experience also suggests that even unsuccessful experiences do not necessarily preclude future projects, given enough time.

The following presents key issues associated with finding champions.

Looking for Champion(s)

Champions are probably already visible because they are proactive in the field of management and operations of transportation systems.

A Champion must be a stakeholder, so they have a vested interest in the outcome.

More than one champion should be identified from different agencies or stakeholder groups:

- Transportation agencies (Traffic, transit, toll authorities, etc.) that support the project because it meets their operational needs.
- Public safety agencies who can bring in other public safety stakeholders.

Champion Skills

- Understanding of the subject,
- Knowledge of local transportation systems and their operation
- Vision for collaboration, partnership, and coordination,
- Consensus builder (facilitator), and
- Executive level access to resources to gain support for various regional efforts.

3.4.3 Corridor Goals, Objectives and Performance Criteria

The goals of corridor traffic management are a broad statement of the long-term outcomes of the program, such as “seamless traffic flow across jurisdictional boundaries”, “enhanced mobility through readily available information”, “safe and efficient movement of goods”, etc. Such goals enable all entities affected by coordinated operations to agree in simple layman’s terms regarding its purpose. Moreover, the development of goals should be a bottom-up process with input coming from the stakeholders. It offers the opportunity to bring all the stakeholders to the table early in the process, leading to a continuing dialog. Goal setting also helps establish priorities and ensure that the coordinated operations program is fully responsive to participants needs. The goals set the stage for the development of objectives and performance criteria.

Establishing goals brings some focus to the corridor traffic management program by establishing broad areas of interest. Because they are not specific in nature, they establish the first level of agreement on areas where coordination and collaboration may be discussed in more detail. An example of a goal would include reduced freeway congestion during incidents by providing improved operation on alternative routes.

The next level of detail is specific objectives. Objectives are generally measurable because they are more specific. An objective might be a 25 percent reduction in incident caused congestion.

The performance measures provide the basis for evaluating the transportation system operating conditions and identifying the location and severity of congestion and other problems. The performance measures provide the mechanism for quantifying the operation of the network, and should also be used to evaluate the effectiveness of implemented traffic management strategies and to identify additional

improvements. Vehicle-hours of delay would be an example of a congestion related performance measure.

There is not a single performance measure or a set of performance measures to meet all needs. It is necessary to evaluate the strengths and weaknesses of alternative approaches to meet alternative needs. This process should be done with the various partners in the process. The following are some characteristics of good performance measures:

- Clearly understood
- Measurable
- Sensitive to modes (person-based)
- Time based (travel time or speed, not volume to capacity or level of service based)
- Link or trip based (in order to provide system monitoring)
- Sensitive to time period (e.g., spreading of peak-period, at least hourly, not daily data)
- Not too difficult or costly to collect.
- Can be forecast into the future.
- Sensitive to the impact of congestion mitigation strategies (on people and/or goods)

Transportation performance measures involve both adequacy and quality of transportation systems. Crucial aspects of adequacy are readily described using congestion measures for determination of sufficiency or deficiency. To describe quality, the complement of congestion must be quantified, namely, mobility or accessibility.

Past definitions of congestion have fallen into two basic categories, those that focus on cause and those that focus on effect. Performance measurements clearly require a definition, which addresses effect, or symptoms, of congestion. Travel time or delays are the typical measures. Congestion is then the travel time or delay in excess of that normally incurred under light or free-flow travel conditions. However, congestion measures have limitations in cross mode comparisons.

Travel time or difference in travel time can be a basic measure. It can be used to compare door-to-door travel times by different modes. Travel rate (e.g., minutes per mile) can be used to account for link specific differences in the transportation network.

Moving to a corridor management approach makes it essential that the performance measures be consistent with the goals and objectives of the process in which they are being employed. It is also important to consider how the performance measures may be used including policy, planning and operational situations.

An example of a corridor goal would be to improve the travel reliability during rush hour. The specific objective might be to reduce the impact of

incidents through better corridor management. The success on reaching the objective could be determined by measure the travel time along the corridor during incidents and comparing the travel time with and without corridor management.

Table 3-2: Example of Goals and Objectives for Corridor Management

GOALS	OBJECTIVES
Improve safety	Reduce accident numbers Reduce accident severity Reduce fatalities
Reduce recurrent congestion	Improve travel time Improve average speed Reduce vehicle hours of delay
Reduce non-recurrent congestion	Improve travel time Improve average speed Reduce vehicle hours of delay
Improve travel reliability	Reduce variation in daily travel time Reduce variation in daily average travel speeds

The establishment of goals and objectives allow stakeholders to reach consensus on what corridor management is attempting to accomplish before getting down to specific alternatives.

3.4.4 Corridor Concept of Operations

The Concept of Operations is a formal document (and therefore shaded in Figure 3-4) that provides a high-level user-oriented view of corridor operations. It is developed to help communicate this view to the other stakeholders and to solicit their feedback. In essence, the Concept of Operations lays out the program concept, explains how things are expected to work once it's in operation, and identifies the responsibilities of the various stakeholders for making this happen. The goals, objectives, and performance measures are also documented. The process to develop a Concept of Operations should involve all stakeholders and serve to build consensus in defining the goals, and objectives; provide an initial definitive expression of how functions are performed, thereby supporting resource planning; and identify the interactions between organizations

By definition, the Concept of Operations does not delve into technology or detailed requirements of the program. Rather, it addresses operational scenarios and objectives, information needs and overall functionality, where the program should be deployed, how users will interact with the

various elements of the program, performance expectations, etc. The Concept of Operations must also address the “institutional” environment in which the corridor operations program is to be deployed, operated, and maintained. This environment includes all the potential users and providers (i.e., stakeholders) and their respective needs and perspectives, the relationships between the coordinated operations program and the policies / procedures of the affected public agencies and private entities, and the necessary coordination (working relationships and agreements) between the stakeholders.

Per the “IEEE Guide for Concept of Operations Documents”, the Concept of Operations:

Provides a means of describing users' operational needs without bogging down in detailed technical issues

Provides a mechanism for documenting a program's (and system's) characteristics and the users' operational needs in a manner that can be verified by the users without requiring them to have any technical knowledge beyond what is required to perform their normal job functions.

Provides a place for users to state their desires, visions, and expectations without requiring them to provide quantified, testable specifications.

Provides a mechanism for users and providers to express their thoughts and concerns on possible solution strategies. In some case, there may be technical or institutional constraints that dictate particular approaches. In other cases, there may be a variety of acceptable solution strategies.

There is no standard outline for a concept of operations. It should reflect both local capabilities and local needs. The following will present one framework, which might be used to develop a concept of operations for corridor traffic management.

The example is a freeway incident diversion plan for a freeway with a parallel corridor. The existing problem is congestion on the freeway, which routinely occurs following incidents. The goal of the project is to reduce incident induced congestion in the corridor. The specific objective is to maximize throughput in the corridor.

The corridor has existing freeway and arterial traffic management systems. Although the freeway has an incident management system, it is not possible to clear incidents quick enough on the freeway for it to return to “normal” levels of congestion without a significant volume of traffic seeking alternative routes.

The focus of the project is better management of the corridor. The concept of operations is to improve incident detection, especially on the arterial, in order to implement congestion mitigation strategies more quickly. Because the two centers must provide coordinated actions, the existing and new control devices must work as part of an integrated system.

During the information-gathering phase prior to an incident, it is necessary to have information on the nature and extent of the incident. On the freeway, this information will come from freeway motorist service patrols. On the arterial, this information will come from the local transit agency who benefits from reduced incident duration.

The information-gathering phase provides the insight into system operation necessary to assess the potential impact of the event. The information provides details on location, characteristics, and potential duration of the event. This information is then used to make an assessment of impact.

Depending on the nature of the impact, potential operational strategies can be considered. At this stage in the process, the assessments are high level. The various stakeholders are determining the level of commitment they are willing to buy into regarding the operational objectives they have defined earlier. More specific details regarding the operational strategies are discussed in Section 3.4.5. At this point the alternatives are largely conceptual, hence the term concept of operations. After the alternatives are defined in more detailed, they eventually become part of the corridor plan, along with other details necessary for implementation.

For the example corridor incident management system, the assessment of impact will lead to the selection from planned strategies. For incidents exceeding agreed upon criteria, the incident management plan will be implemented. It will include adjusting appropriate ramp meters (reduce metering rates – restrict flow – upstream and increase or eliminate rates downstream to all diverted traffic easy re-entry), displaying appropriate messages on existing or new DMS signs, providing higher levels of bus priority to maintain transit reliability, and adjusting signal timing to reflect changes in traffic patterns and volumes.

While technically outside the scope of a corridor traffic management plan, regional traffic advisories may be appropriate when incident conditions exceed thresholds for regional traffic advisories.

At the concept of operations stage, planning level estimates may be made on the resource requirements to achieve the high level concept of operations. This would include estimates of capital and operating costs.

The Concept of Operations may or may not become a “published” document depending on how the project moves forward. If the project is competing for resources in the region, the Concept of Operations may be a planning level document for seeking project support. It is also possible that the Concept of Operations document becomes part of the Corridor Plan. That is likely the result of the project moving forward to a more detailed level of development as described in the next two sections.

3.4.5 Identification of Corridor Scenarios and Improvement Strategies

This step takes the concept of operations and develops the details necessary to accomplish the concept of operations described in the previous step. This section will provide an overview of the process of identifying scenarios and selecting appropriate strategies. Details concerning the potential strategies are discussed in Chapter 4.

In this step, a determination is made – in a more detailed manner than in the Concept of Operations – what the corridor traffic management program should do. This step can run through several iterative cycles of defining, reviewing, and refining the requirements. A key point related to this step is that the end product must be a set of requirements on whose meaning everyone agrees. In the parlance of “Systems Engineering”, requirements are statements of the capabilities that the program strategies and supporting systems must have (i.e., “functions”), geared to addressing the mission-oriented objectives of the stakeholders. For requirements to be most useful, they should be statements of what is desired, not descriptions of how the need should be satisfied.

The process of selecting strategies begins with the identification of scenarios. Scenarios are the conditions that trigger a particular strategy. For example, if one lane is closed mid-day due to an incident, the strategy may be to implement freeway DMS messages and implement upstream meter to reduce traffic volume and create some natural diversion.

If the scenario is there will be two lanes closed during rush hour, the strategy may include implementation of diversion strategies along the parallel arterial specific to the location and direction of the incident. The scenarios are formulated to represent the conditions (location and extent), which might be addressed by a particular strategy that may include a number of specific actions. The actions may include signal timing adjustments as well as various traveler information approaches.

The types of strategies that are appropriate for corridor management:

- Traveler information,
- Traffic management and control, and
- Shared information and resources.

The difference in perspective for the strategies above is they are viewed from a corridor management perspective. Traffic control strategies, for example, transcend agency boundaries and focus on corridor safety and throughput. Traveler information not only identifies the nature of the problem, but also provides information on potential alternative actions.

While many strategies may be easily assessed, the next section discusses a more formal evaluation process. This may be necessary for

complex alternatives or to allow all parties to understand the impacts of the potential strategies being considered.

3.4.6 Selection and Evaluation of Strategies

Strategies that require multiple stakeholders are more complex because of competition for resources. Therefore, details of a particular strategy may have profound effects on how a project is ultimately viewed by other than the lead agency. It is therefore necessary to have a flexible approach to selection of potential strategies, realizing the all parties must be willing to support the potential strategy. This chapter provides an overview of the evaluation and selection process. Chapter 4 will explain the process in more detail. Chapters 5-8 provide specific strategies to accommodate the four types of events that are amenable to corridor traffic management: incidents, work zones, special events, and day-to-day congestion,

The assessment of strategies can vary from simple pragmatic assessments to detailed simulation studies. The appropriateness of the evaluation method depends on the complexity of the alternatives and the cost of implementation. The analysis of coordinated signal timing across jurisdictional boundaries can be undertaken with any of a number of computer analysis tools. However, the cost of implementing coordinated timing may be modest compared to the cost of developing a detailed study. Never the less, the need to develop timing plans may in fact provide the necessary documentation of the benefits of the effort.

A variety of means can be used for prioritizing projects including many traditional economic analysis tools like benefit/cost ratio. Categories of funding are often created to address specific problems such as safety or capacity. Others use rankings based on weighted evaluation criteria. The criteria should represent the goals and objectives of the local area, with relative importance being reflected in the weights. Criteria could, for example, include improve system performance, and improve air quality.

The last element of the evaluation is the expected outcomes. These are the measures of effectiveness, which should be measured in order to determine:

Whether the strategies meet their objectives

How the strategies can be changed to better meet operational objectives

Whether the strategies are realistic, or should be modified; and

Additional resources and tools that are needed to meet the objectives.

3.4.7 Corridor Plan

A regional corridor traffic management plan is the primary product of corridor operations collaboration and coordination. It is a strategy for achieving the shared vision of operations developed in the corridor concept of operations. It defines expectations (what is to be accomplished) over time, processes (how it will be accomplished), and resources (investments in time, money, staff, and equipment) for better operations and system performance. It also addresses how agencies and jurisdictions work together to achieve better system performance and operations.

Corridor operations collaboration and coordination relies on activities and relationships that can occur only if individuals and organizations commit appropriate funding, staff, and possibly equipment. Implicit in this statement is the allocation, and possible sharing, of resources that enables a region's operators, service providers, and other stakeholders to improve system performance. Operations must be viewed as a resource priority to participating organizations. The Corridor Plan must address the availability of resources for putting into practice a concept of operations, implementing an agreed-upon strategy, and sustaining operations on an ongoing basis.

Corridor collaboration depends on the availability and commitment of resources to fund the concept of operations, corridor plan, and other agreed-upon actions. Most funding for operations will come from individual agency budgets. This may involve agreements to share key resources (equipment and personnel) across jurisdictional boundaries or among operators or service providers; agreements on acquisition and procurement that ensure interoperability and standard protocols for communications and data exchange; or potentially, the identification of capital investments in operations-related infrastructure (networks, operations centers, sensors) to be deployed on a regional basis or in conjunction with other capital improvement projects. Funding for such projects requires that operating agencies and service providers have a role in the region's capital planning process and that regional planners share an operating vision. The allocation of capital resources to operations improvements must complement or augment capital investments in expanded capacity.

Effective collaboration and coordination among organizations depends on the availability of qualified staff and related resources to do the work needed to support the regional collaboration and coordination effort. This will require purposeful job descriptions that translate into full time equivalents (FTEs) dedicated to collaborative activities. Interagency or interregional positions may be needed to facilitate the collaboration among organizations or jurisdictions. It is also necessary that those who work in these positions perceive a return on investment of their time

dedicated to coordination and collaboration.

How collaborative processes are funded and staffed reflects a commitment to and vision for the effort. Typically, when a few individuals or organizations see a need to solve a problem or improve performance or when agencies agree to work together on a project of regional importance, resources may then be applied in the form of in-kind contributions from participating organizations or through program funds administered by a single agency on behalf of all participants. As the collaborative activities mature, participating entities (including both public and private sectors) may choose to pool resources and eventually align with, or form entities that assume responsibility on behalf of participating agencies and jurisdictions. These entities should also establish positions with authority, accountability, and responsibility for coordinated operations.

Performance measures are a key to assessing the success of efforts to collaborate and coordinate and to identifying areas where improvement is needed or possible. The first step related to performance improvement is finding a general consensus that performance measures are needed if corridor performance is to improve. Given this consensus, performance measures relevant to system users must be developed and accepted as meaningful methods of assessing both the short-term and long-term operation of the corridor. Because corridor operations collaboration and coordination is an evolving process, the performance measures themselves may change, resulting from changes in institutional relationships, technology applications, and policy and procedures. So that the operators and service providers in each corridor understand whether goals are being met, they should regularly report on and discuss whether performance measures accurately reflect a successful vision of transportation system operation as part of the process of collaboration and coordination.

The performance measurement process is also an important part of the broader need for continuous improvement. Traffic operations, by its nature, is a continually changing environment. As development takes place or traffic patterns change, system performance will also change, requiring a revaluation of current operations.

The result of a proceeding steps result in a project plan and/or corridor plans. If only one project is involved in a corridor, the project plan is essential the corridor plan. If more than one project is involved in a corridor, the corridor plan is a more extensive document.

The corridor plan is a formal document (and therefore shown shaded in Figure 3-4) that provides complete details on first eight steps of the process including program of strategies, plus the details necessary take

the plan to the steps necessary for implementing them. The plan outlines the various projects, their priorities, potential funding, and the schedule for implementation.

The corridor plan must have sufficient detail to take the project to detailed design as discussed in Section 3.4.8. The development and evaluation of the strategies necessary to improve corridor operations is discussed in more detail in the next chapter.

3.4.8 Design and Development

The design phase translates each of the various projects included in the corridor plan into implementable project plans. The nature of the plans depends on the nature of the project. Infrastructure projects will include the technology necessary for providing the support necessary to implement corridor traffic management plans. Operational projects would provide the operational plans necessary to achieve the strategies selected in response to scenarios anticipated as strategies to mitigate various conditions that adversely affect corridor operations.

The level of detail will depend on the strategy and necessary supporting infrastructure. Simple strategies such as cross-jurisdictional coordination of signal timings may be implementable without new infrastructure upon establishment of common cycle lengths and coordination references between jurisdictions. However, more complicated incident management plans may require more complicated control technology in order to implement the strategy in an effective and timely manner.

Additional information on the strategies that are being implemented are included in Chapters 4-8. In addition, Information on designing projects with technology components is covered in more detail in Chapter 9, Supporting Technology and ITS Elements. Examples of specific scenarios are included in Chapters 10-13.

3.4.9 Implementation

Implementation of corridor traffic management projects can be more complicated because of their multi-organization nature. Additional operating agreements may be necessary, especially if control is given to organizations outside the responsible operating agency.

However, challenges occurring because of different operating rules or philosophies can also be turned into opportunities if the collaborating agencies seek to find the most effective approach to implementation. For example, one organization may better equipped to manage a particular type of contract. If the collaborating organization sees the opportunity in letting another organization manage the project, the result may actually be a faster and better implementation.

Because comprehensive projects involve multiple agencies and jurisdictions, a carefully crafted plan is very important. Key aspects of a successful implementation are (22):

- Clear responsibilities.
- Useful results.
- High level of coordination and cooperation.
- Full participation by all jurisdictions.
- Timely arrival of accurate data.
- Must be seen as a priority to implement.
- Integration with planning and programming.
- Coordination with statewide plans and management systems.

In any process, it is important to realize that perseverance is necessary to make it happen on a continual basis. Primary factors in sustaining the process will be clear lines of accountability/responsibility, coordination, and cooperation between all involved agencies.

3.4.10 Operations and Maintenance

The focus of this document is improved management and operations. However, operations and maintenance have been the Achilles Heel of improving operations in general. It is one of the areas that have often gotten limited attention due to the priority on construction of new projects. However, it is important to realize that operations are but one cog in a much larger system. If the overall process is not understood and utilized, the potential for operations to carry its share of the load is diminished.

Operations

The system operators take actions to implement the strategies that are appropriate to the prevailing conditions. These actions lead to results and outcomes, measured by the performance monitoring system, that consequently feed back and affect the formulation of the policies, goals, and objectives, and influence the planning and programming process. This “feedback” element of the process allows practitioners to assess the effectiveness of their efforts, to identify areas for improvement, to demonstrate the benefits provided by the program, and to support requests for additional resources

A freeway and arterial operations program is a continuous process, one that must take into account changes in the local operational, technological, political, and funding environment. Based on the results of the evaluations, the coordinated operations program may be expanded (geographically and / or functionally), and the policies and operational strategies may be modified. It may also require developing a revised vision, new requirements, different approaches, etc. – in essence, continually exercising all the previous steps.

It is important that the operators understand that their actions directly contribute to achieving the program's goals and objectives. The more successful the operations program in meeting the overall goals of the agency (as measured by performance monitoring), the more strongly supported it will be. The program is not simply operating the system, but providing the resources needed (equipment, software, tools, staffing, training, etc.) in a systematic approach (e.g., systems engineering) to develop an overall approach to support operations and make it as effective as possible.

Another important consideration is that corridor traffic management is only one part of the many transportation management systems and operations activities that may exist within a metropolitan area, state, or multi state region. Corridor management should be implemented systematically and be coordinated with all the activities typically undertaken to operate the transportation network. This requires cooperation with neighboring governmental jurisdictions, regional transportation agencies, and organizations that provide or are involved with transportation related services.

Maintenance

Maintenance has often been the weak link in managing the surface transportation system. A recent General Accounting Office report² indicated that nearly 90 percent of traffic signal systems were not functioning to minimum standards of performance due to inadequate maintenance. Without adequate consideration of maintenance, inefficiency will begin to develop shortly after implementation of a project. Maintenance costs should be factored into every corridor traffic management project.

Corridor traffic management systems may be complex, integrated amalgamations of hardware, technologies and processes for data acquisition, command and control, computing and communication. Accordingly, maintenance can be a complex proposition as well, requiring sophisticated approaches and advanced technology. Maintenance of the systems is a necessity to ensure reliability and proper operation, thereby protecting the investment and enabling the system to respond to changing conditions. Failure to function as intended could negatively impact traffic safety, reduce system capacity, and ultimately lead the traveling public to lose faith in their transportation system. Failure of the system also has the potential to cause measurable economic loss and increase congestion, fuel consumption, pollutants, and traffic accidents.

There are several references that address maintenance of transportation management systems and components, including the ITE publication "Traffic Control System Operations – Installation, Management and Maintenance" (Reference 13) and "Guidelines For Transportation

Management Systems Maintenance Concepts and Plans” (Reference 14). Both documents discuss maintenance management (e.g., organizational structure, personnel and staffing), options for performing maintenance (e.g., in-house, contract), and guidelines for performing maintenance on a variety of system components – the former document addressing field devices, computers, and communications; the latter focusing more on Transportation Management Centers.

Maintenance considerations must be an integral part of any process to develop a coordinated operations program must be part of all the steps and activities in that process – for example, involving maintenance stakeholders, developing a maintenance concept, including maintenance and replacement costs in the life cycle analyses of alternative technologies / components, identifying maintenance functional requirements, including resources to carry out maintenance functions in the resource allocation process, etc. In this manner the coordinated operations program and any enabling systems will include the necessary resources, environment, and procedures to maintain the infrastructure associated with the program / system; transportation management center and its associated infrastructure.

The Maintenance Concept (a “Concept of Maintenance”) is designed to articulate the essential reliability and performance measures necessary to meet stated operational concepts. Just as the Concept of Operations drives the system functional requirements, the Maintenance Concept drives the Maintenance Requirements. These maintenance requirements then become enabling requirements for input into the system design phase and other implementation and operation phases in the system life cycle. Thus, the Maintenance Concept is a central element of any maintenance plan or program. The Maintenance Concept imposes a structured approach to the development of maintenance requirements that is traceable back to an operational concept (14).

3.4.11 Continuous Improvement

The overall process was presented earlier in Figure XY. The process is drawn as a continuous circle. As the system is being operated and maintained, the system must be continually monitored. The monitoring process sets in motion another cycle of performance evaluation/problem identification, identification of improvement strategies, evaluation, prioritization, design, deployment/implementation, operations, maintenance, and so on. Without such a process, the corridor (and the overall system) will fail to perform at optimum effectiveness and efficiency.

3.5 NEXT STEPS

This chapter has presented the regional context and the 11-step process to develop a coordinated freeway and arterial operations program. The first four steps in the process are essential Phase I of the process, which result in the first formal product, the Corridor Concept of Operations.

The remainder of the report is organized as follows.

- Development of a Corridor Plan (Chapter 4)
- Typical Applications (Chapters 5-8)
 - Traffic Incident Management
 - Construction and Maintenance Zone Management
 - Planned Special Events Management
 - Day-to-Day Management
- Supporting Technologies and ITS Elements (Chapter 9)
- Example Applications (Chapters 10-13)

The next chapter will address in more detail the development and evaluation of strategies that are generally applicable to coordinated freeway and arterial operations. These strategies will form the basis of developing a Corridor Plan, which includes:

- Roles, responsibilities, and procedures
- Activation criteria
- Infrastructure needs and costs
- Operating resources and costs
- Maintenance requirements and costs
- Implementation priorities and schedule
- Updating process.

¹ Regional Concept of Transportation Operations, Final Report, Maricopa Council of Governments, November, 2003,
<http://www.mag.maricopa.gov/detail.cms?item=3335>